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(54) **METHOD AND APPARATUS FOR OPTICAL SIGNAL POWER DISCRIMINATION**

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H04B 10/12	(2006.01)
H04B 10/00	(2006.01)

(52) **U.S. Cl.** **398/201**; 398/135; 398/188

(58) **Field of Classification Search** 398/201
See application file for complete search history.

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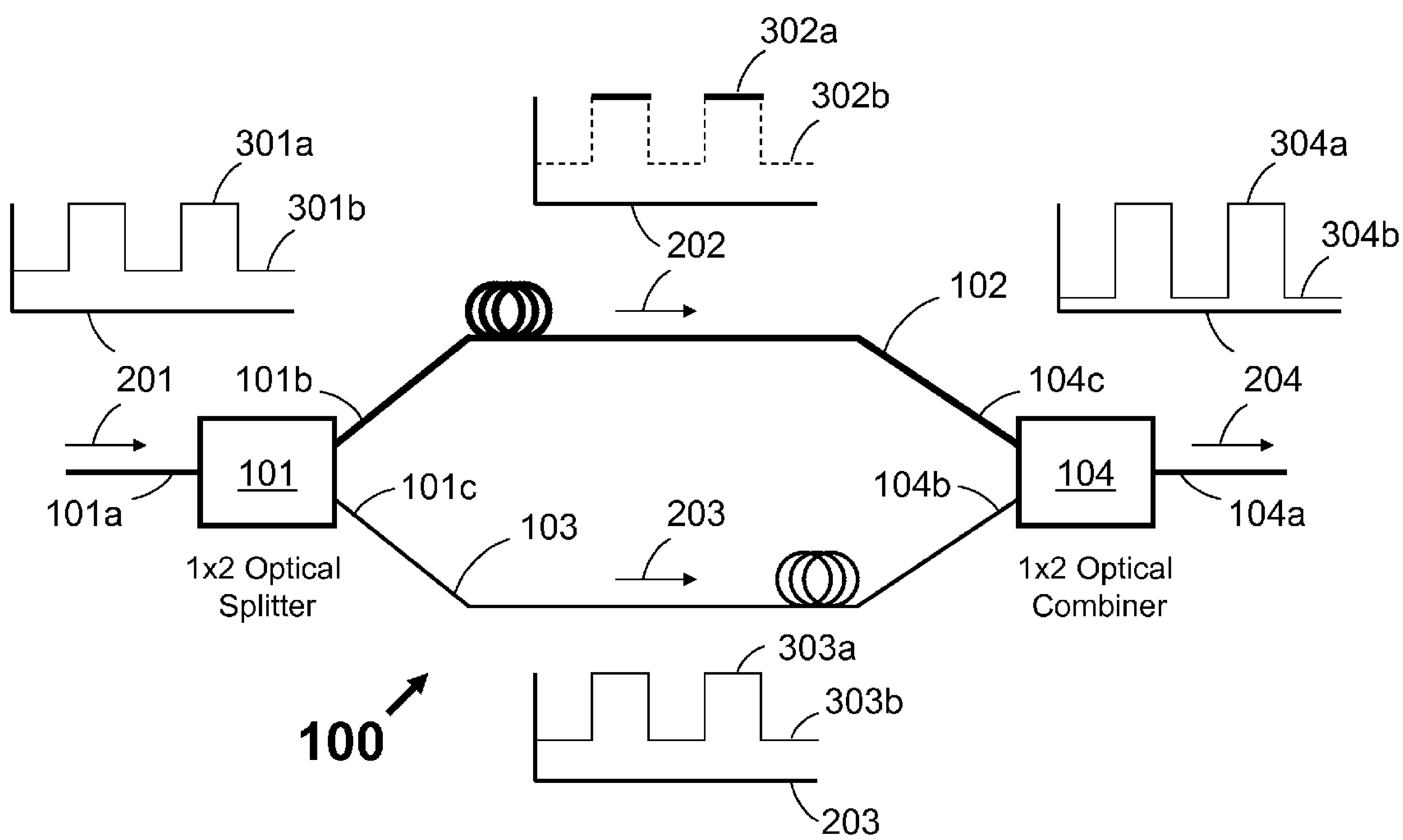
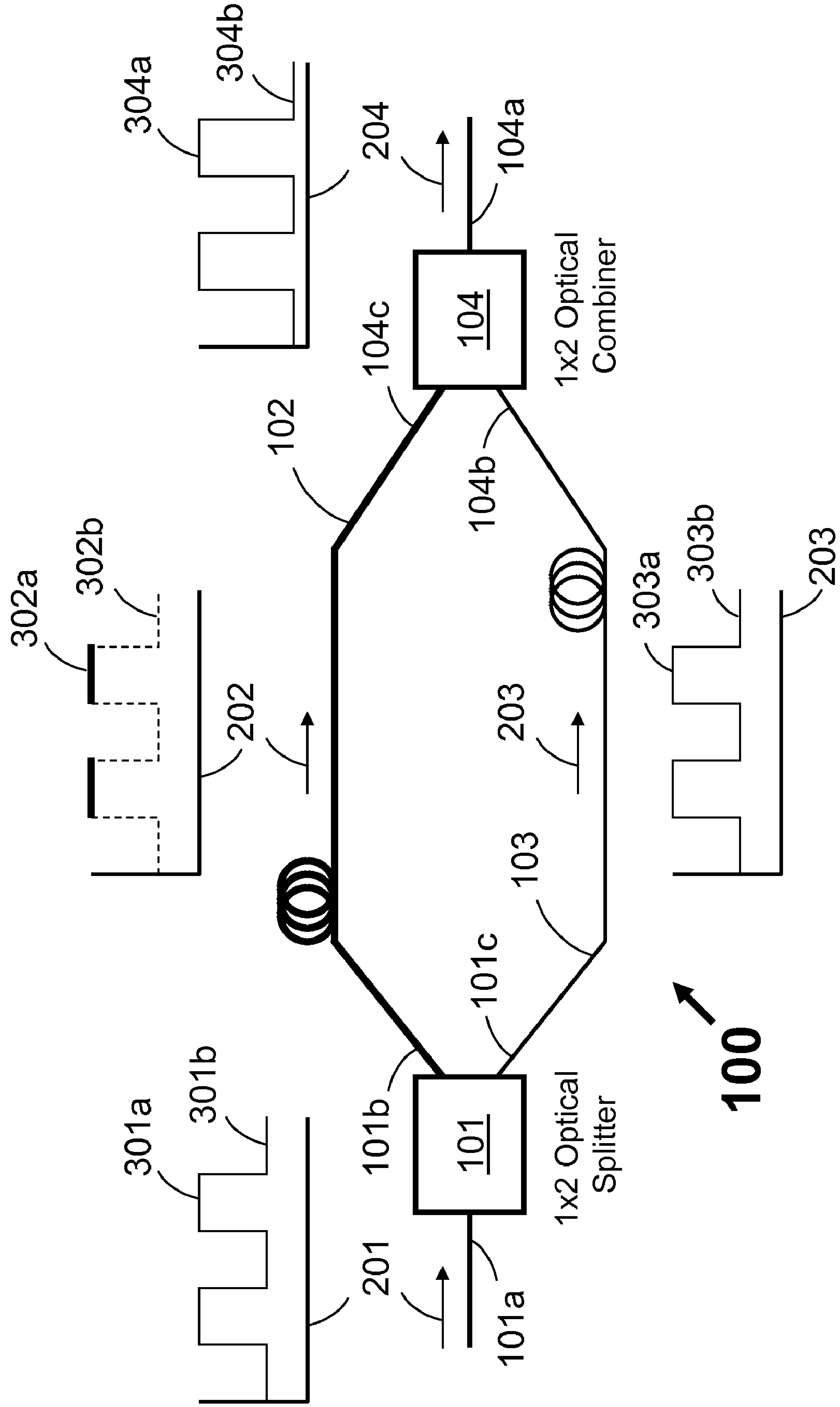
(57) **ABSTRACT**

The present invention provides an optical power level discriminating device and method for discriminating optical power levels. The optical discriminating device includes a splitter for receiving an optical signal having first and second signal states, and splitting the received optical signal into a first and a second branch optical signal. A first optical fiber for transporting the first branch optical signal is provided that is made of a material having a high non-linear refractive index providing a different non-linear phase shift to the first and second signal states of the first branch optical signal. A second optical fiber is provided for transporting the second branch optical signal with little or no non-linear effect. The discriminating device also includes a combiner for combining the first branch optical signal and second branch optical signal to produce an output optical signal. The output signal is resulted from a constructive interference between the first signal states of the first and second branch optical signals, and a destructive interference between the second signal states of the first and second branch optical signals.

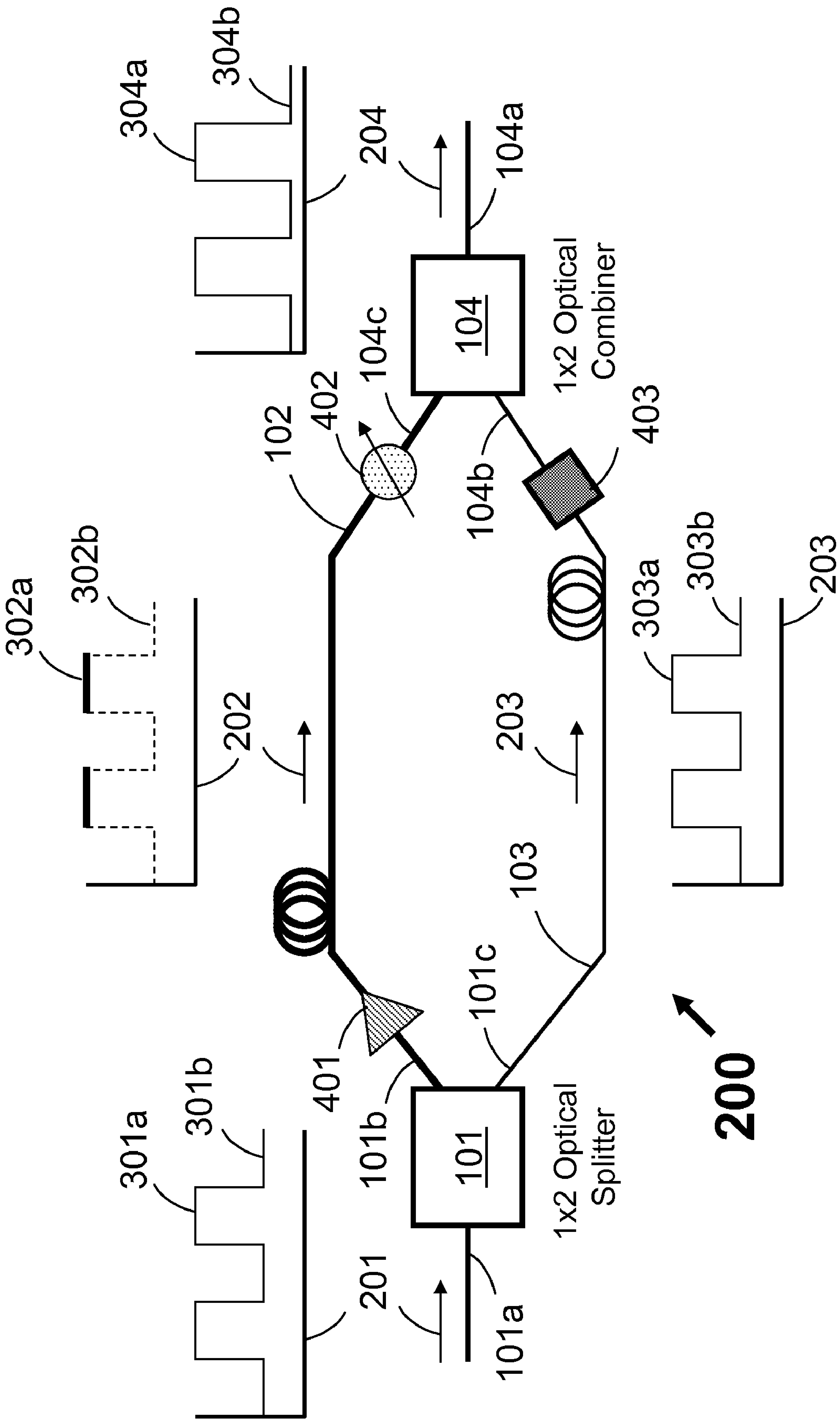
24 Claims, 4 Drawing Sheets





101
1x2 Optical Splitter
104
1x2 Optical Combiner
101a
101b
101c
102
103
104a
104b
104c
201
202
203
203
204
301a
301b
302a
302b
303a
303b
304a
304b
100

FIG. 1



301a
301b
201
101a
101
1x2 Optical Splitter
101b
401
101c
103
200
302a
302b
202
203
303a
303b
203
102
402
104c
104b
403
104
1x2 Optical Combiner
104a
204
304a
304b

FIG. 2

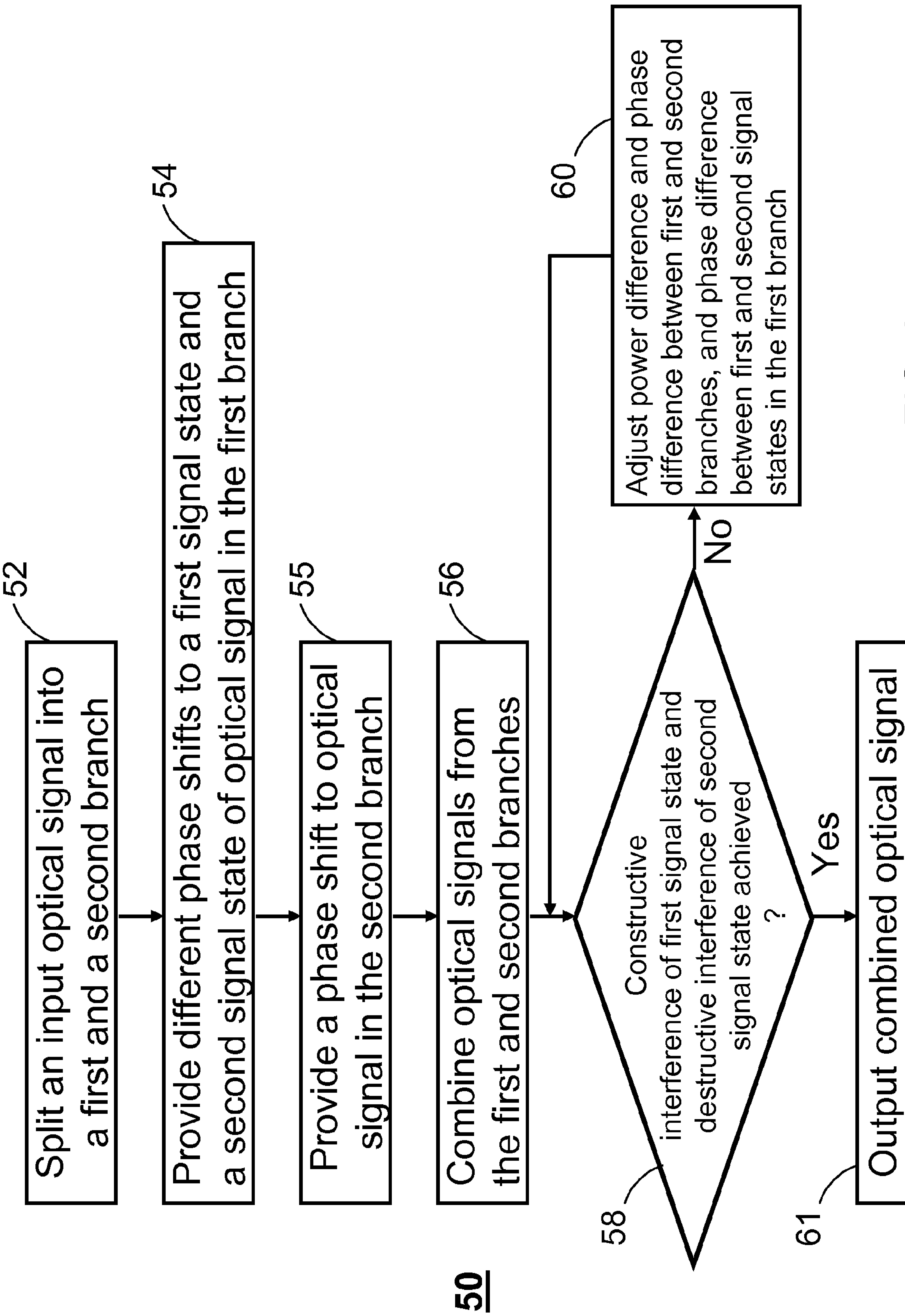

50
52
Split an input optical signal into a first and a second branch
54
Provide different phase shifts to a first signal state and a second signal state of optical signal in the first branch
55
Provide a phase shift to optical signal in the second branch
56
Combine optical signals from the first and second branches
58
Constructive interference of first signal state and destructive interference of second signal state achieved ?
No
60
Adjust power difference and phase difference between first and second branches, and phase difference between first and second signal states in the first branch
Yes
61
Output combined optical signal

FIG. 3

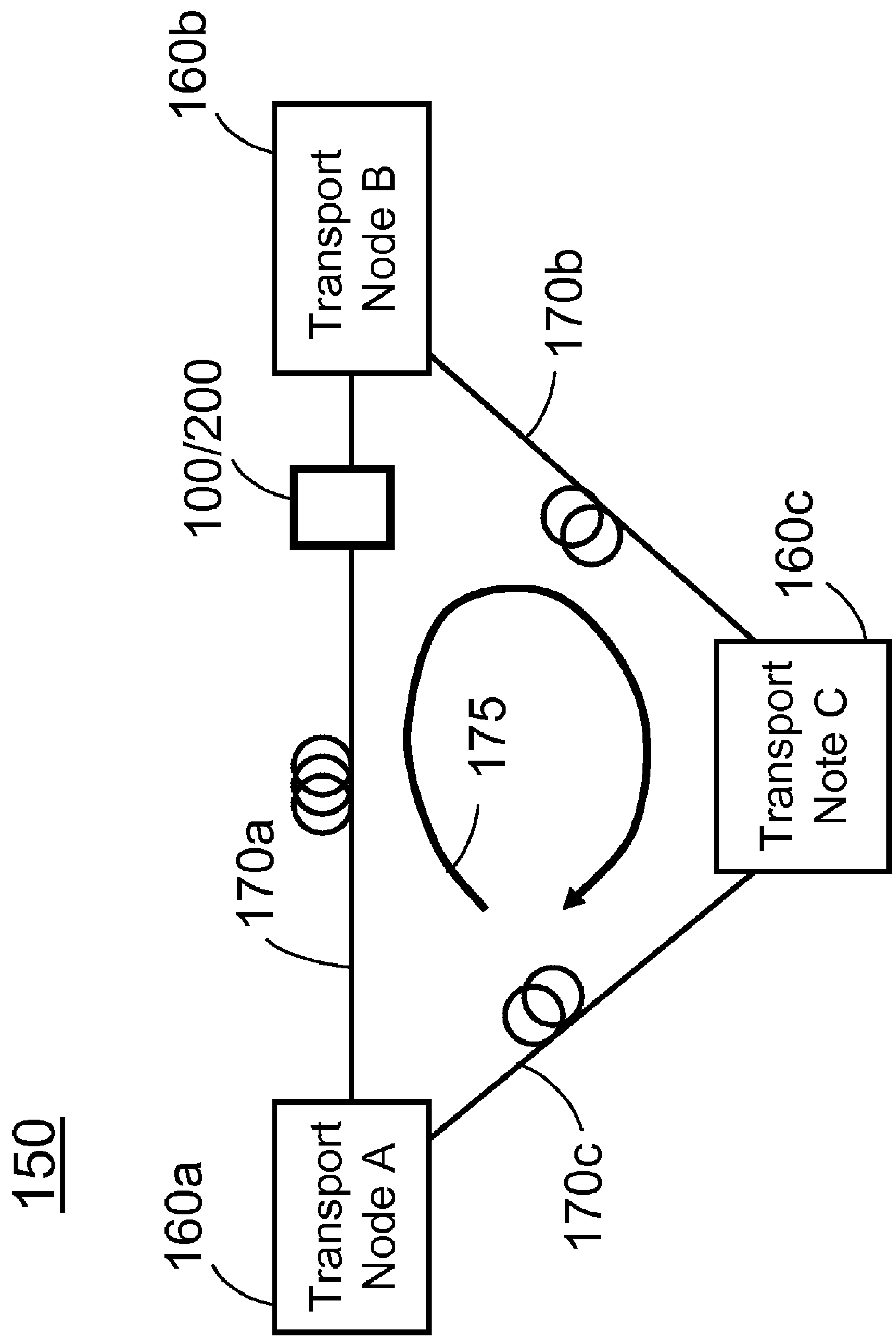

150
160a
Transport Node A
160b
Transport Node B
160c
Transport Note C
100/200
170a
170b
170c
175

FIG. 4

METHOD AND APPARATUS FOR OPTICAL SIGNAL POWER DISCRIMINATION

FIELD OF THE INVENTION

The present invention relates to optical networks, and more particularly relates to an optical signal power handling device that discriminates optical signal states having different optical signal power levels.

BACKGROUND

Optical networks transport optical signals. An optical network usually includes nodes and spans, for example fiber spans or other optical transmission media. Digital optical signals having multiple states, for example one state representing a logic "1" and one state representing a logic "0", are generally transported, optically, between two adjacent nodes across a fiber span. Once a digital optical signal reaches a node at the end of the fiber span, it is usually converted into a digital electrical signal for content processing.

Optical communication systems or networks must be able to maintain a good quality of digital optical signals during transportation. Hereinafter, the terms "optical signal" and "digital optical signal" may be used interchangeably with both meaning a binary digital optical signal having one state representing a logic "1" and one state representing a logic "0". In recognizing the need for high quality optical signal, which may include for example power level and extinction ratio of the optical signal, various efforts have been devoted so far toward developing optical signal processing devices that may be used to manipulate and/or control the optical signal in the optical domain.

An optical amplifier is one such device that may be used to enhance the power level of an optical signal. However, there are currently no optical devices that can improve the extinction ratio, a ratio of power of the state of logic "1" over the state of logic "0", of an existing optical signal without first converting it into an electrical signal. Such an optical signal power handling device or "optical signal discriminator", as may be referred to hereinafter, will play a major role in both current and future optical signal processing technologies by virtue that the optical signal discriminator has the capability of reshaping and reconstructing original digital information in the optical domain. In the meantime, by improving the extinction ratio of an optical signal, an optical signal discriminator may be able to greatly improve receiver sensitivity of a node, in an optical network, that receives the digital optical signal, resulting in a low bit-error-rate and high fidelity of optical signal transmission.

SUMMARY

It would be highly desirable to provide a system and method for discriminating digital optical signal states associated with their power levels for use in optical networks.

In one embodiment, there is provided a method of discriminating power levels of an optical signal. The method comprises splitting an input optical signal into first and second branch signals, the input optical signal having first and second signal states; providing a first phase shift to the first signal state of the first branch signal; providing a second phase shift to the second signal state of the first branch signal; and, combining the first branch and second branch signals to produce an output optical signal, the combining causing a constructive interference between the first signal states of the first and second branch signals, and a destructive interference between the second signal states of the first and second branch signals.

A device for discriminating power levels of optical signals is also provided. The optical signal discriminator device comprises: a splitter for receiving an input optical signal having first and second signal states, and splitting the received optical signal into a first branch signal and a second branch signal; a first optical signal path, attached to a first output port of the splitter, for transporting the first branch signal, the first optical signal path providing a first phase shift to the first signal state of the first branch signal and a second phase shift to the second signal state of the first branch signal, wherein the first phase shift is different from the second phase shift; a second optical signal path, attached to a second output port of the splitter, for transporting the second branch signal; and a combiner having a first and a second input port being attached to the first optical signal path and the second optical signal path respectively, the combiner combining the first branch signal and the second branch signal to produce an output optical signal, the output optical signal resulting from a constructive interference between the first signal states of the first and second branch signals, and a destructive interference between the second signal states of the first and second branch signals.

According to a further aspect, there is provided an optical network comprising: at least a first optical network node including a transmitting device for transmitting an optical signal along an optical fiber for receipt at a second optical network node by a receiving device; the second optical network node including the receiving device; and

an optical discriminator device in series connection with the optical fiber between the first and second optical network nodes. The optical discriminator device comprises: a splitter for receiving the optical signal having first and second signal states, and splitting the received optical signal into a first branch signal and second branch signal; a first optical fiber for transporting the first branch signal, the first optical fiber having a non-linear refractive index causing a first and a second phase shift to the first and second signal states of the first branch signal; a second optical fiber for transporting the second branch signal; and a combiner for combining the first branch signal and the second branch signal to produce an output optical signal, the output optical signal resulting from a constructive interference between the first signal states of the first and second branch signals, and a destructive interference between the second signal states of the first and second branch signals, wherein the output signal is received at the second optical network node by the receiving device.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Other aspects, features and advantages of the present invention will become more fully apparent from the following detailed description, the appended claims, and the accompanying drawings in which similar elements are given similar reference numerals.

FIG. **1** illustrates a demonstrative configuration of an optical signal discriminator **100** in accordance with one embodiment of the invention;

FIG. **2** illustrates several alternative configurations of optical signal discriminators according to other embodiments of the invention;

FIG. **3** depicts a simplified flowchart of a method in creating constructive interference of optical logic "1" state and destructive interference of optical logic "0" state; and

FIG. **4** depicts a demonstrative system of optical network employing an optical signal discriminator for reshaping optical signal for improved extinction ratio.

DETAILED DESCRIPTION

FIG. **1** illustrates a demonstrative configuration of an optical power discriminator **100** in accordance with one embodiment of the invention. Apparatus **100** may provide discrimination of optical signal levels and/or states according to an embodiment of the invention. Optical power discriminator apparatus **100** includes: an input optical splitting device **101**, which may be a 1×2 optical splitter in the embodiment depicted, having one input port **101***a* and two output ports **101***b*, **101***c*; and an output optical combining device **104**, which may be a 1×2 optical combiner in the embodiment depicted, having two input ports **104***b*, **104***c* and one output port **104***a*. A first optical signal path **102**, which may be a first optical fiber for example, connects a first output port **101***b* of optical splitting device **101** to a first input port **104***c* of optical combining device **104**, and a second optical signal path **103**, which may be a second optical fiber for example, connects a second output port **101***c* of optical splitting device **101** to a second input port **104***b* of optical combining device **104**.

It should be understood that, the optical splitter **101** and combiner **104** are both bi-directional devices. That is, a splitter becomes a combiner when light/optical signal inside propagates in the opposite direction. Additionally, as known, splitter **101** and/or combiner **104** may be made of, for example, directional couplers, Y-branches, etc.

In further view of FIG. **1**, optical fiber **102** preferably has a high optical intensity dependent refractive index, commonly known as non-linear refractive index. Optical fiber **103** preferably has a low non-linear refractive index, or a refractive index that is less dependent on optical intensity. Further, alternately, optical fiber **102** may have a relatively small cross-sectional area, which may create a higher optical intensity under a certain input optical power, thereby enhancing its non-linear effect on an optical signal propagating therein, and optical fiber **103** may have a relatively big cross-sectional area, which may cause a lower optical intensity under the same amount of input optical power as that in optical fiber **102**, thereby having lower or no non-linear effect on an optical signal propagating therein.

Optical splitting device **101** (or splitter) and combining device **104** (or combiner) may be configured to have various combinations of power splitting and/or combining ratios. For example, in one embodiment, the optical splitting device **101** and combining device **104** may both be a 50:50 splitter and combiner. In this embodiment, because optical powers propagating inside fibers **102** and **103** are the same (absent other power altering devices, like an amplifier and/or an attenuator as being described below in connection with alternate embodiments), optical fibers **102** and **103** may be different, having either different non-linear refractive indices or cross-sectional areas for example, to have different amount of non-linear effect and, as a result, provide different amount of phase shifts to optical signals propagating therein, respectively, as being described below in more detail.

In an alternate embodiment, optical splitter **101** may be, for example, a 80:20 splitter with 80% of the signal power to/from (first) output port **101***b*. In this case, optical combiner **104** may be a 20:80 (inverse ratio of splitter **101**) combiner, with 20% of the signal power from/to (first) input port **104***c*, which is connected to first output port **101***b* of optical splitter **101** through optical signal path **102**. In general, if the power splitting ratio of splitter **101** is x:y, then the power combining ratio of combiner **104** shall be y:x, assuming losses of first optical signal path **102** and second optical signal path **103** to optical signals are substantially the same. This way, inside combiner **104**, same amount of optical powers may come from first optical signal path **102** (or first optical fiber) and from second optical signal path **103** (or second optical fiber) to create constructive interference at a logic "1" signal level or state and destructive interference at a logic "0" signal level or state, as being described below in more detail.

In further view of FIG. **1**, in operation, an optical signal **201** may be launched into input port **101***a* of splitter **101**. Signal **201**, for purposes of the following description, is a binary signal represented by a series of pulses at a first state **301***a* (representing a logic "1") and a second state **301***b* (representing a logic "0"). As shown in FIG. **1**, second state **301***b* may contain certain amount of power (a ground level noise, for example) and is thus not a true "0" state. In other words, optical signal **201** exhibits a poor extinction ratio (i.e., a low ratio of optical power of "1" state over "0" state). Inside splitter **101**, input optical signal **201** is split into first branch signal **202** propagating via splitter output port **101***b* along optical fiber **102**, and second branch signal **203** propagating via splitter output port **101***c* along optical fiber **103**.

Given the example description of input optical signal **201** being split into two branch optical signals **202** and **203**, the following occurs: branch optical signal **202** propagating inside fiber **102**, which has a large non-linear refractive index that is optical signal intensity dependent, is subject to a self-phase modulation (SPM) inside fiber **102** that may cause different states ("1" and "0") of optical signal **202**, at different power levels, to experience different non-linear phase shifts ("first" and "second" phase shifts). According to one embodiment, difference in phase shift between "1" state **302***a* and "0" state **302***b* of signal **202** shown in FIG. **1** may amount to 180 degrees, or 180+N×360 degrees, where N is a whole number. In other words, "1" state **302***a* and "0" state **302***b* may become "out-of-phase", represented by the dark solid line and the light dashed line in FIG. **1**. On the other hand, branch optical signal **203** propagating inside fiber **103**, which has a small non-linear refractive index, may experience little or no non-linear phase shift. In other words, "1" state **303***a* and "0" state **303***b* of branch optical signal **203** may experience or accumulate zero phase difference and remain "in-phase", represented by the same solid line style.

As mentioned in view of FIG. **1**, optical combiner **104** may combine branch optical signals **202** and **203** to produce an output optical signal **204** which exits via output port **104***a* of combiner **104**. When the "1" state **302***a* of branch optical signal **202** is arranged to be in-phase with the "1" state **303***a* of branch optical signal **203**, constructive interference between the two "1" states occurs which may produce a "1" state **304***a* of output optical signal **204**. According to one embodiment of the invention, phase adjustment between branch optical signals **202** and **203** may be achieved by adjusting the length of optical fiber **102** and/or **103**, and/or using a phase shifter as being described below in more details with reference to FIG. **2**.

In the meantime, there occurs destructive interference between "0" state **302***b* of branch optical signal **202** and "0" state **303***b* of branch optical signal **203** since they are out-of-phase, which may produce a largely diminished "0" state **304***b* of output optical signal **204**. The amount of power in "0" state **304***b* of output optical signal **204** is generally smaller than that of "0" state **301***b* of input optical signal **201**, and in the ideal condition may become a true "0", indicating that signal **204** has an improved extinction ratio which is general preferably for reducing error-rate during signal detection.

In one embodiment, optical signal path **102** may be an optical fiber made of materials with high non-linear refractive index. Miller's rule, which is a semi-empirical relation for predicting nonlinearity, implies that a high linear refractive index generally leads to large non-linear (Kerr) refractive index. In the embodiment depicted, materials making optical fiber **102** may include, for example, a chalcogenide glass having a rather large refractive index, between 2 and 3. As known, chalcogenide glass materials exhibit significantly larger non-linear refractive indices than other glasses. Typically, their non-linear refractive indices in the telecommunication C-band (~1550 nm) are about two to three orders of magnitude greater than that of fused silica. Chalcogenide glasses suitable for making optical fiber **102** may generally include chalcogen elements including, but not limited to, sulfur, selenium and tellurium and may be combined with one or more other elements, commonly germanium, silicon, phosphorous, arsenic and antimony.

The amount of non-linear phase shift an optical signal may experience while propagating inside an optical fiber may be estimated by equation (1) as follows:

$$\Phi=r*P*L \tag{1}$$

Here, r is a nonlinearity coefficient that is proportional to the nonlinear-index coefficient n_2 of the fiber material, and inversely proportional to the effective cross-sectional area A_{eff} of the fiber. In a typical fused fiber, r may be about 20 W^{-1} km^{-1}. In the above equation, P is the optical signal power; and L is the fiber length. Thus, for example, in order to achieve a phase shift $\Phi=\pi$ under an input optical power condition of 20 mW and inside a regular fused fiber, an optical fiber length of around 8 km would be sufficient. If a fiber of higher non-linear index is used (such as the chalcogenide glass above whose non-linear refractive index is 2~3 orders of magnitude larger), the required fiber length may become much less.

FIG. **2** illustrates alternative configurations of optical signal discriminators according to other embodiments of the invention. As shown in FIG. **2**, discriminator **200** includes, along optical signal paths **102** and/or **103** connecting splitter **101** and combiner **104**, one or more optical amplifier, attenuator and/or phase shifter devices. Each of the amplifier, attenuator and phase shifter elements may be used individually or in different combination with the configuration shown in FIG. **2** as one possibility.

An optical amplifier, such as optical amplifier **401** connected at the output port **101***b* of splitter **101**, may be used to boost the optical signal power level launched into optical fiber **102** in order to enhance the non-linear effect of self-phase modulation (SPM) that branch optical signal **202** experiences inside optical fiber **102**. That is, an amplifier connecting an output of the splitter to the first optical fiber boosts the power of the first and second signal states of the first branch signal, thereby enhancing a non-linear effect of the first optical fiber **102**.

As further shown in FIG. **2**, an attenuator **402** may be used to adjust the optical power level from fiber **102** into combiner **104** in such a way that a correct amount of power may be used to enable the constructive (for logic "1" state) or destructive (for logic "0" state) interference with signals coming from fiber **103**. Attenuator **402** may be used in combination with the combining ratio of combiner **104**. Although attenuator **402** is illustratively shown in optical signal path **102** or optical fiber **102** in FIG. **2**, it may be placed in optical signal path **103** depending upon the actual need of power adjustment.

Additionally, a linear phase shifter **403** may be used to ensure and/or adjust the phase shift of optical signal **203** in fiber **103** such that logic "1" state **303***a* of optical signal **203** in fiber **103** is substantially "in-phase" (having a phase difference substantially close to zero or N×360 degrees with N being a whole number) with logic "1" state **302***a* of optical signal **202** in fiber **102**. In other words, logic "0" state **303***b* of optical signal **203** in fiber **103** is also substantially "out-of-phase" with logic "0" state **302***b* of optical signal **202** in fiber **102**. As being described above, logic "1" state **302***a* of optical signal **202** is "out-of-phase" with logic "0" state **302***b* of optical signal **202** because of non-linear phase shift. That is, the linear phase shifter may be employed for adjusting a phase shift of the first and second signal power levels of the second branch signal in the second optical fiber **103**, thereby causing the constructive interference between said first signal states of the first and second branch signals, and the destructive interference between the second signal states of the first and second branch signals.

FIG. **3** depicts a simplified flowchart illustrating a method **50** of creating constructive interference of optical logic "1" state and destructive interference of optical logic "0" state of an input optical signal. As shown in FIG. **3**, method **50** includes a step **52** of splitting an input optical signal into first and second branch signals. The splitting may be made according to a power split ratio x:y, where x is the amount of input power being splitted and/or launched into a first branch optical signal path (e.g., fiber **102**) and y is the amount of input power being splitted and/or launched into a second branch optical signal path (e.g., fiber **103**). Then, at step **54**, the method includes a step of providing different phase shifts to a first signal state, e.g., logic state "1", and a second signal state, e.g., logic state "0", of the first branch signal. The amount of non-linear phase shift (being provided may be dependent on the power levels of different signal states being launched into non-linear optical signal path **102**. For instance, in one application, the difference of non-linear phase shift being provided to the logic state "1" and the logic state "0" may be substantially close to 180 degrees or N×360 degrees, where N is a whole number.

FIG. **3** further includes a step **55** of optionally providing a linear phase shift to the branch signal in the second optical signal path (e.g., optical fiber **103**). This phase shift may be equally applied to both the logic "1" state and the logic "0" state of the branch signal **203**. The linear phase shift may be applied to make logic "1" state **303***a* of branch signal **203** "in-phase" with logic "1" state **302***a* of branch signal **202**, and logic "0" state **303***b* of branch signal **203** "out-of-phase" with logic "0" state **302***b* of branch signal **202**.

Continuing at step **56**, the method may include a further step of combining the branch signals (or branch optical signals) **202** and **203**, carried by the first and second optical signal paths **102** and **103**, to produce an output optical signal **204** (FIG. **1** and FIG. **2**). Then, at a following step **58**, a determination is made on whether proper constructive interference of the logic "1" signal state ("first signal state") and destructive interference of the logic "0" signal state ("second signal state") have been achieved.

If it is determined that constructive and/or destructive interference have been not properly achieved yet, then the method proceeds to a next step **60**.

In order to achieve both desirable constructive interference for logic "1" signal state and desirable destructive interference for logic "0" signal state, it may be necessary, at step **60**, to adjust the power levels and/or individual phase shift of the two interfering branch optical signals, as well as the phase difference between the two signal states "1" and "0" of one of the branch optical signal. This may be accomplished by the use of one or more optical amplifier, attenuator and/or phase shifter devices in the branch optical signal paths such as those shown in the embodiment depicted in FIG. **2**, and by adjusting and/or carefully selecting the type of fiber used and the length used, if the optical signal paths are optical fibers.

For example, in order to achieve a certain phase difference between logic state “0” and logic state “1” of optical signal **202** in fiber **102**, the non-linear effect of SPM may be adjusted by either using an amplifier to increase or using an attenuator to decrease the level of optical signal power launched into optical fiber **102**, and/or by selecting the type of fiber with proper non-refractive index and the length of fiber to accumulate a proper non-linear phase shift. Further for example, a phase shifter, preferably a linear phase shifter, may be used in one of the branch optical signal paths, either **102** or **103**, to achieve “in-phase” status (e.g., substantially close to zero, or N×360 degrees, where N is a whole number) of logic “1” states of branch optical signals **202** and **203**, or “out-of-phase” status (e.g., substantially close to 180 degrees, or 180+N×360 degrees, where N is a whole number) of logic “0” states of branch optical signals **202** and **203** to ensure constructive interference at logic state “1” and destructive interference at logic state “0” of optical signals **202**, **203**. It should be understood that steps **58** and **60** may be repeated by looping as shown in FIG. **3**, in order to reach a pre-determined quality of optical signal for the particular application. Finally, the combined optical signal is output at step **61**.

An optical signal power handling device or optical power discriminator, as those being described above, may be used in an optical network, for example, at a receiver side of an optical node to enhance the extinction ratio of optical signals being received, according to one embodiment of the present invention. Normally, as an optical signal propagates through an optical transmission media such as a fiber, various noises may be added onto the optical signal. The optical signals can only be detected at above a certain signal-to-noise ratio often due to limitation in receiver sensitivity. In addition, the optical transmission media such as fiber may also induce dispersion to cause pulse spread of the digital optical signal, which further degrades the receiver sensitivity. Both noise and dispersion increase with the increase in transmission distance and are generally more pronounced at higher data rates, which in the end limits the attainable distance and data rate of the optical transmission system. With the introduction of the optical power handling device or optical signal discriminator, when being used properly at a receiver side, the discriminator, such as discriminator **100** or **200** shown in FIGS. **1** and **2**, may be able to reshape a dispersion distorted and/or noise loaded optical signal to achieve a better extinction ratio, which ultimately leads to improved system bit error rate (BER).

FIG. **4** depicts a demonstrative system of optical network employing an optical discriminator for reshaping optical signal for improved extinction ratio. In FIG. **4**, system **150** includes an optical network having transport nodes **160***a*, **160***b*, **160***c* for transmitting and/or receiving optical signals transmitted along optical fiber spans **170***a*, **170***b*, **170***c*. For example, in optical network system **150**, optical signals may travel along a path direction **175** such that optical signals are transmitted or launched out of transport node **160***a*, along fiber span **170***a* for receipt at transport node **160***b* which further transmits optical signals along fiber span **170***b* for receipt at transport node **160***c* which send signals along the fiber span **170***c* back to originator transport node **160***a*. An optical signal discriminator, such as discriminator **100** described herein with respect to FIG. **1** or discriminator **200** described herein with respect to FIG. **2** may be incorporated at a certain location in series with, for example, fiber span **170***a* (as shown in FIG. **4**), in order to enhance signal extinction ratio received at the receiver of node **160***b*. Alternately, optical power discriminator(s) may be disposed in series with fiber span **170***b* and/or **170***c* for the same purpose. The location and placement of the discriminator may be optimized to achieve improved system performance.

Although a few examples of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes might be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. A method comprising:

splitting an input optical signal into first and second branch signals, said input optical signal having first and second signal states;

providing a first phase shift to said first signal state of said first branch signal;

providing a second phase shift to said second signal state of said first branch signal; and,

combining said first branch and second branch signals to produce an output optical signal, said combining causing a constructive interference between said first signal states of said first and second branch signals, and a destructive interference between said second signal states of said first and second branch signals.

2. The method of claim **1**, wherein said first phase shift is substantially close to 180 degree different from said second phase shift.

3. The method of claim **1**, wherein providing said first and second phase shifts comprises causing non-linear self-phase modulation to said first and second signal states of said first branch signal.

4. The method of claim **1**, wherein providing said first and second phase shifts comprises causing said first branch signal to pass through an optical fiber made of a chalcogenide glass material having a non-linear refractive index between 2 and 3.

5. The method of claim **4**, wherein said chalcogenide glass material includes chalcogen element of sulfur, selenium and tellurium, and at least one of the following elements: germanium, silicon, phosphorous, arsenic and antimony.

6. The method of claim **1**, further comprising:

adjusting optical signal powers of said first and second branch signals to have a substantially same amount at said first signal state and at said second signal state respectively, and combining the adjusted first and second branch signals to produce said output optical signal.

7. The method of claim **1**, further comprising:

adjusting a phase difference between said first signal states of said first and second branch signals to be substantially close to zero to result in said constructive interference.

8. The method of claim **1**, further comprising:

adjusting a phase difference between said second signal states of said first and second branch signals to be substantially close to 180-degree to result in said destructive interference.

9. An optical signal discriminator comprising:

a splitter for receiving an input optical signal having first and second signal states, and splitting said received optical signal into a first branch signal and a second branch signal;

a first optical signal path, attached to a first output port of said splitter, for transporting said first branch signal, said first optical signal path providing a first phase shift to said first signal state of said first branch signal and a second phase shift to said second signal state of said first branch signal, wherein said first phase shift is different from said second phase shift;

a second optical signal path, attached to a second output port of said splitter, for transporting said second branch signal; and

a combiner having a first and a second input port being attached to said first optical signal path and said second optical signal path respectively, said combiner combining said first branch signal and said second branch signal to produce an output optical signal, said output optical signal resulting from a constructive interference between said first signal states of said first and second branch signals, and a destructive interference between said second signal states of said first and second branch signals.

10. The optical signal discriminator of claim **9**, wherein said first and second optical signal paths are first and second optical fibers, said first optical fiber having a large non-linear refractive index, said non-linear refractive index providing different amount of self-phase modulation to said first and second signal states of said first branch signal, causing said first and second phase shifts.

11. The optical signal discriminator of claim **10**, wherein said first optical fiber is made of a chalcogenide glass material, having a non-linear refractive index between 2 and 3.

12. The optical signal discriminator of claim **11**, wherein said chalcogenide glass material includes chalcogen element of sulfur, selenium and tellurium, and at least one of the following elements: germanium, silicon, phosphorous, arsenic and antimony.

13. The optical signal discriminator of claim **9**, wherein said splitter provides a power splitting ratio of x:y toward said first and second optical signal paths respectively, where x represents a power level of said first branch signal and y represents a power level of said second branch signal, and wherein said combiner provides a power combining ratio of y:x coming from said first and second optical signal paths respectively.

14. The optical signal discriminator of claim **9**, wherein said splitter splits said input optical power 50:50 into said first optical signal path and said second optical signal path, and wherein said combiner combines said first and second branch signals, from said first and second optical signal paths respectively, in a ratio of 50:50.

15. The optical signal discriminator of claim **10**, further comprising:

an amplifier connecting said first output port of said splitter to said first optical fiber for boosting power of said first and second signal states of said first branch signal, thereby enhancing said self-phase modulation to said first and second signal states of said first branch signal.

16. The optical signal discriminator of claim **10**, further comprising:

an attenuator in series with said first optical fiber for adjusting power of said first branch signal in such a way that a correct amount of power may be used for causing said constructive interference between said first signal states of said first and second branch signals, and said destructive interference between said second signal states of said first and second branch signals.

17. The optical signal discriminator of claim **10**, further comprising:

a linear phase shifter for adjusting a phase shift of said first and second signal states of said second branch signal in said second optical fiber, thereby causing said constructive interference between said first signal states of said first and second branch signals, and said destructive interference between said second signal states of said first and second branch signals.

18. An optical network comprising:

at least a first optical network node including a transmitting device for transmitting an optical signal along an optical fiber for receipt at a second optical network node by a receiving device;

said second optical network node including said receiving device; and

an optical discriminator device in series connection with said optical fiber between said first and second optical network nodes, said optical discriminator device comprising:

a splitter for receiving said optical signal having first and second signal states, and splitting said received optical signal into a first branch signal and second branch signal;

a first optical fiber for transporting said first branch signal, said first optical fiber having a non-linear refractive index causing a first and a second phase shift to said first and second signal states of said first branch signal;

a second optical fiber for transporting said second branch signal; and

a combiner for combining said first branch signal and said second branch signal to produce an output optical signal, said output optical signal resulting from a constructive interference between said first signal states of said first and second branch signals, and a destructive interference between said second signal states of said first and second branch signals,

wherein said output signal is received at said second optical network node by said receiving device.

19. The optical network of claim **18**, wherein said splitter provides a power splitting ratio of x:y where x represents a power level of said first branch signal and y represents a power level of said second branch signal, and wherein said combiner has a power combining ratio of y:x.

20. The optical network of claim **18**, wherein said first optical fiber is of a chalcogenide glass material, having a non-linear refractive index between 2 and 3.

21. The optical network of claim **20**, wherein said chalcogenide glass material includes chalcogen element of sulfur, selenium and tellurium, and at least one of the following elements: germanium, silicon, phosphorous, arsenic and antimony.

22. The optical network of claim **18**, further comprising:

an amplifier connecting an output of said splitter to said first optical fiber for boosting power of said first and second signal states of said first branch signal, thereby enhancing a non-linear effect of said first optical fiber.

23. The optical network of claim **18**, further comprising:

an attenuator in series with said first optical fiber for adjusting power of said first branch signal in such a way that a correct amount of power may be used for causing said constructive interference between said first signal states of said first and second branch signals, and said destructive interference between said second signal states of said first and second branch signals.

24. The optical network of claim **18**, further comprising:

a linear phase shifter for adjusting a phase shift of said first and second signal power levels of said second branch signal in said second optical fiber, thereby causing said constructive interference between said first signal states of said first and second branch signals, and said destructive interference between said second signal states of said first and second branch signals.

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